

## **APPENDIX E - ENVIRONMENTAL PROJECTS**

### **APPENDIX E-1: CATERPILLAR ENVIRONMENTAL PROJECT FOR UNITED STATES AND CALIFORNIA**

#### **IN-USE EMISSION REDUCTION OF NONROAD CI ENGINES**

##### **PURPOSE**

DEVELOP RETROFIT KIT(S) FOR SPECIFIC NONROAD CI ENGINES TO REDUCE NOX. THIS PROJECT WOULD TARGET NONROAD CI ENGINES OPERATING IN URBAN NON-ATTAINMENT AREAS BASED UPON THE NOX REDUCTION POTENTIAL.

##### **DEVELOPMENT PROGRAM**

PHASE 1A: IDENTIFY CATERPILLAR NONROAD CI ENGINES THAT HAVE HIGH USAGE IN URBAN NON-ATTAINMENT AREAS AND IDENTIFY THE PROBABLE FUTURE USAGE OF THESE NONROAD CI ENGINES.

PHASE 1B: IDENTIFY SUITABLE OPTIONS TO REDUCE TONS OF NOX. THESE OPTIONS WOULD INCLUDE: ENGINE MODIFICATIONS TO REDUCE ENGINE OUT EMISSIONS, AFTERTREATMENT TECHNOLOGY TO RETROFIT ON EXISTING ENGINES AND/OR NONROAD CI ENGINE REPLACEMENT WITH LOWER EMISSIONS ENGINES. THIS INVESTIGATION WILL ALSO INCLUDE COOLING SYSTEM AND OTHER MODIFICATIONS REQUIRED TO RETROFIT THE ENGINE EMISSION CONTROL SYSTEM CHANGES. THE RESULT OF THIS PHASE WILL BE THE LIST OF POTENTIAL TONS OF NOX REDUCTION FROM NONROAD CI ENGINES IN NON-ATTAINMENT AREAS AND THE ASSOCIATED COSTS. THE GOAL WILL BE TO IDENTIFY THE MAXIMUM PRACTICABLE NOX REDUCTIONS THAT CAN BE ACHIEVED IN A COST-EFFECTIVE MANNER.

PHASE 1C: FINALIZE THE SPECIFIC PROPOSAL FOR PHASE 2, BASED UPON CONSIDERATION OF TOTAL TONS OF POTENTIAL NOX REDUCTION, COST TO ACHIEVE THE NOX REDUCTION, DOLLARS PER TON REDUCTION AND THE IMPACT ON URBAN NON-ATTAINMENT AREAS.

PHASE 2A: DEVELOP THE SPECIFIC ENGINE AND/OR AFTERTREATMENT TECHNOLOGY IDENTIFIED IN PHASE 1. VALIDATE THE RELIABILITY AND DURABILITY OF THE CHANGES USING LABORATORY ENDURANCE TESTS.

PHASE 2B: DESIGN AND DEVELOP THE MACHINE HARDWARE REQUIRED TO RETROFIT THE ENGINE EMISSIONS CONTROL SYSTEM INTO THE TARGET APPLICATIONS.

PHASE 3: PROCURE HARDWARE FOR SEVERAL NONROAD CI ENGINE APPLICATIONS (NUMBER TO BE DETERMINED) AND PLACE IN NON-ATTAINMENT URBAN FIELD SITES. RECORD OPERATING AND MAINTENANCE DATA AND PERFORM PERIODIC INSPECTIONS OF THE MACHINES TO IDENTIFY ANY OPERATIONAL PROBLEMS WITH THE LOW EMISSIONS CONTROL SYSTEM CONFIGURATION. FIELD TESTING WILL CONTINUE FOR AT LEAST TWO YEARS TO DETERMINE EMISSIONS, PERFORMANCE, AND LIFE RESULTS.

PHASE 4. HELP FUND THE COST OF PROCUREMENT AND INSTALLATION OF THE NONROAD CI ENGINE TECHNOLOGY IN NON-ATTAINMENT AREAS. WHERE POSSIBLE, SELECTION OF AREAS FOR IMPLEMENTATION OF THIS PHASE WILL BE IDENTIFIED BASED UPON THE OPPORTUNITY TO

MAXIMIZE THE ENVIRONMENTAL BENEFIT IN A COST-EFFECTIVE MANNER. DOCUMENTS AND OTHER STATEMENTS PREPARED AND USED SOLELY WITH INDIVIDUAL CUSTOMERS ARE NOT SUBJECT TO THE PROVISIONS OF PARAGRAPH 100.

IMPACT TO ENVIRONMENT

REDUCE NOX THAT IS A PRECURSOR TO OZONE AND SECONDARY PARTICULATE EMISSIONS.

COST ALLOCATION

UNITED STATES: \$9,000,000

CALIFORNIA: \$4,000,000

## **APPENDIX E-2: CATERPILLAR ENVIRONMENTAL PROJECT FOR UNITED STATES**

### **HYBRID ENGINE SYSTEM PROJECT**

#### PURPOSE

DEMONSTRATE, IN A GREATER THAN 8500 POUND GVW HYBRID VEHICLE, THE EMISSIONS EQUIVALENT TO 1.0 G/HP-HR (NOX + HC) AND .05 G/HP-HR PARTICULATE IN A CONVENTIONAL VEHICLE. ALSO DEMONSTRATE IMPROVED PERFORMANCE AND FUEL ECONOMY AND REDUCED CO2 EMISSIONS OVER THAT OF A CONVENTIONAL VEHICLE. DEVELOPMENT PRIORITY WILL BE FOR LOW PM.

#### DEVELOPMENT PROGRAM

PHASE 1: CONCEPT A HDDE ENGINE HYBRID SYSTEM AND DETERMINE SYSTEM COMPONENT REQUIREMENTS USING ANALYTICAL MODELS TO DETERMINE COMPONENT SIZE AND EFFICIENCY TO MEET VEHICLE PERFORMANCE REQUIREMENTS.

PHASE 2: DEVELOP COMPONENTS TO MEET THE TARGETS DETERMINED IN PHASE 1 FOR A CONVENTIONAL ENGINE POWERED HYBRID SYSTEM. DEVELOP THE CONVENTIONAL ENGINE AND HYBRID SYSTEM TO ACHIEVE THE EMISSIONS TARGETS, USING EGR, AND ADVANCED AFTERTREATMENT SYSTEMS AS REQUIRED.

PHASE 3: DEMONSTRATE THE TOTAL VEHICLE. DEMONSTRATE PERFORMANCE AND EMISSIONS OVER A TYPICAL PICKUP AND DELIVERY CYCLE.

PHASE 4: DEMONSTRATE THE EMISSIONS AND PERFORMANCE GOAL IN THE FIELD BY CONDUCTING A 1 YEAR 3 - 5 VEHICLE FIELD TEST.

#### IMPACT TO ENVIRONMENT

REDUCE NOX, WHICH IS A PRECURSOR TO OZONE, AND PRIMARY AND SECONDARY PARTICULATE EMISSIONS. IMPROVE FUEL ECONOMY AND REDUCE CO2 EMISSIONS.

#### PROJECT COST

UNITED STATES: \$4,800,000

## **APPENDIX E 3: CATERPILLAR ENVIRONMENTAL PROJECT FOR CALIFORNIA**

### **DUAL FUEL ENGINE PROGRAM**

#### PURPOSE:

CURRENTLY POWER SYSTEMS ASSOCIATES, A CATERPILLAR DEALER OFFERS CONVERSION KITS WHICH CONVERT THE CATERPILLAR C-12 AND 3126 DIESEL ENGINES TO DUAL FUEL OPERATION. DUAL FUEL OPERATION INVOLVES BURNING LNG, LPG OR CNG WITH DIESEL FUEL PILOT IGNITION. THE MARKET PENETRATION OF THESE CLEANER ENGINES COULD BE INCREASED THROUGH SEVERAL INITIATIVES.

#### POSSIBLE PROGRAMS:

PRODUCT DEVELOPMENT: DEVELOP THE C10 ONE YEAR EARLIER THAN PLANNED, DEVELOP A DUAL FUEL 3406E, DEVELOP A PROPANE 3126 AND C12.

CHANNEL TO MARKET: DEVELOP THE DUAL FUEL ENGINES TO BECOME FACTORY OFFERINGS RATHER THAN DIESEL CONVERSIONS. THIS CHANGE WOULD INCREASE CHASSIS AVAILABILITY SINCE SEVERAL OEMS ARE RELUCTANT TO OFFER DUAL FUEL ENGINES FROM THEIR FACTORY UNLESS THEY ARE CATERPILLAR FACTORY OFFERED ENGINES.

OWNING AND OPERATING COSTS: THE OVERALL COST OF OWNING AND OPERATING THE VEHICLE MUST BE ADVANTAGED BY USING NATURAL GAS. TODAY IN CALIFORNIA, A TAX BILL IS EXPECTED TO BE SIGNED INTO LAW WILL PROVIDE GRANTS TO COVER THE INCREMENTAL COST OF THE VEHICLE. GRANT MONEY IS AVAILABLE AS WELL TO FUND A PORTION OF THE INVESTMENT IN FUELING STATIONS. NATURAL GAS FUEL TODAY IN THE FORM OF LNG IS SLIGHTLY HIGHER THAN DIESEL BECAUSE OF COSTS OF TRANSPORTING THE FUEL FROM OUTSIDE THE STATE. LOCAL LIQUEFACTION IS NEEDED TO BRING DOWN THE PRICE OF LNG TO THE CALIFORNIA MARKET. WITH SUCH SUPPLIES, LNG COULD BE DELIVERED AT PRICES INCLUDING ALL TAXES 10% TO 25% BELOW DIESEL ON AN EQUIVALENT BTU BASIS.

#### DEVELOPMENT PROGRAM

THE SPECIFIC PROGRAM WILL BE DEVELOPED WITH THE AFTER DETERMINING OF THE GREATEST OPPORTUNITIES FOR NOX REDUCTION.

#### IMPACT ON THE ENVIRONMENT

THE DUAL FUEL ENGINES ARE CERTIFIED AT 2.5 NOX. THEREFORE, THE DUAL FUEL ENGINES ARE FURTHER ADVANCING THE 2004 REGULATIONS.

#### PROJECT COST:

CALIFORNIA: \$1,000,000